

130J-1

ROPEWORK

130-J

UNIT OBJECTIVE

After completion of this unit, students will be able to identify and care for ropes, know and understand knots, hitches, and their use, know selection, splicing, and use of different ropes. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the students will be able to:

1. List five common uses of rope.
2. Identify samples of natural and synthetic fiber ropes.
3. List the factors to consider when selecting rope.
4. Describe three important practices in rope care.
5. Construct crown, eye, short, and side-loop splices (or make a rope halter, using the splices).
6. Tie three types of common hitches.
7. Tie three types of common knots.

SELECTION AND USES OF ROPE

A. Uses of Rope

1. Ropes are used to secure livestock and pets through the use of halters, leadropes, and leashes.
2. Heavy loads, such as hay and straw, are secured with ropes.
3. Rope is used in rural recreation for water skiing and mountain climbing. It is also used to tie camping gear on pack mules, horses, and vehicles.
4. Heavy objects are lifted and moved through the use of block and tackle.
5. Ropes are used to support trees and shrubs, secure tents, and act as support lines, guide wires, and clothesline.

B. Factors to Consider in Rope Selection

1. Use

- a. Different uses require different kinds, sizes, and lengths of rope.

2. Construction

- a. Rope is made from a variety of materials, each of which has different physical characteristics.
- b. Rope construction varies depending on the material from which it is made. Natural fiber ropes are usually woven while synthetic ropes are often braided.

3. Size

- a. Rope comes in a range of diameters and lengths.
- b. Common diameters of rope are 1/4," 5/16," 3/8," 1/2," 5/8," 3/4," 7/8," and 1."

4. Strength

- a. Rope strength is measured as a breaking load. The breaking load is the amount of weight a rope can hold without being pulled apart.
- b. Rope strength depends on the diameter and the material of which it is made.

5. Flexibility

- a. Flexibility determines the ease with which rope can be handled or worked.

6. Durability

- a. The rope's durability is determined by its ability to resist deterioration when exposed to chemicals, sunlight, water, and abrasion.

7. Cost

- a. The cost of a rope varies depending upon the material from which it is made, the diameter, and the weight.
- b. Rope is sold either by the foot or by the weight.

Table J-1

Safe Working Strength of New Fiber Rope¹

Working Strength (Pounds)

Rope

Diameter, Natural Fiber			Synthetic Fiber			
inches	Manila	Sisal	Nylon	Dacron	Polyethylene	Saran
3/8"	200	150	400	390	300	150
1/2"	440	350	780	745	600	300
5/8"	880	700	1,710	1,355	1,100	620
3/4"	1,080	865	2,000	1,870	1,600	800
7/8"	1,540	1,230	2,700	2,520	2,120	1,140
1"	1,800	1,440	3,600	3,220	2,800	1,600

1. Taken from Rope on the Farm, Farmers' Bulletin No. 2130, United States Department of Agriculture.

2. Actual breaking strengths are at least 5 times the figures given.

ACTIVITY:

1. Complete a chart or matrix that will list the application, type, and size of various kinds of rope.
2. Through class discussion or written quizzes, identify uses of rope around the home, in agriculture, and in rural recreation. Determine the appropriate size and type of rope for varying uses.

ROPE IDENTIFICATION AND CARE

A. Types of Materials Used in Making Ropes

1 Natural Fiber Ropes

- a. Manila rope is woven from the fibers of the Abaca plant, which is native to the Philippines. It is the strongest and most pliable of the natural rope fibers, but it is also the most expensive. Manila rope is susceptible to rot and decay if it becomes wet.
- b. Sisal rope is lighter in color and has a rougher texture than manila. Sisal is made from the fibers of the Agave plant found in Mexico, Central America, East Africa, and the Bahamas. It is not as strong as manila rope, but sisal is more resistant to abrasion. The coarse texture of sisal rope makes it undesirable for use on animals. The older baler twine is made of sisal.
- c. Cotton rope is the most common natural fiber rope used in the United States. Although it is not as strong as manila and sisal, cotton rope is more desirable in livestock handling due to its softer surface texture. Cotton rope is also susceptible to rot and decay and has a tendency to swell when it gets wet, which decreases its workability.

2. Synthetic Fiber Ropes

- a. Nylon and dacron ropes are the strongest synthetic ropes available. They are soft, pliable, and less susceptible to rot and mildew than natural fiber ropes. Although these ropes do stretch when wet, they retain their strength under wet conditions. Excessive heat will melt nylon and dacron ropes and long exposure to sunlight will cause the fibers to become brittle and decay.
- b. Polypropylene and polyethylene ropes have a coarser texture and are less pliable than nylon and dacron. "Poly" rope is also susceptible to damage from heat and sunlight. "Poly" rope is widely used because it is readily available and much cheaper than all other synthetic ropes. Polyethylene rope also floats in water, making it useful for boat and dock work.
- c. Wire rope is normally used for extra heavy pulling or lifting jobs. It is also commonly used in fencing. Wire rope consists of steel wires wrapped around a fiber or smaller wire rope core. The solid core of the wire rope makes it very rigid and difficult to work. The steel must be oiled or greased to prevent rusting. Wire rope is many times more expensive than synthetic and natural fiber ropes.

B. Caring for Rope

1. Inspect ropes regularly for nicks, cuts, and abrasion damage.
 - a. Avoid dragging rope over rough or damaged surfaces.
 - b. Avoid stepping on or laying heavy objects on rope.
 - c. Use synthetic ropes where rope may come in contact with oils, acids, or chemicals.
 - d. Whip or splice the ends of rope to prevent unraveling.
2. Proper storage can increase the longevity of ropes.
 - a. Do not store synthetic ropes where they will be exposed to heat or sunlight for long periods of time.
 - b. Rope should be stored coiled and in a dry place.
 - c. Hang ropes off the ground.

Table J-2

Types of Rope Available for Restraining Livestock¹

Type of Fiber	----- Breaking Strength (pounds) -----				
	3/8"	1/2"	5/8"	3/4"	1"
Cotton	890	1,450	2,150	3,100	5,100
Sisal	1,080	2,120	3,250	4,320	7,200
Manila	1,350	2,650	4,400	5,400	9,000
Polypropylene	2,650	4,200	5,700	8,200	14,000
Nylon	4,000	7,100	10,500	14,200	24,600

Advantages	Disadvantages	Suggested Uses
Cotton soft, flexible least likely to cause ropeburning intermediate in cost	least strong low abrasion resistance will rot and deteriorate	tying of animal limbs neck ropes hobbles lead ropes, if 5/8" or larger
Sisal-same as manila, except that sisal is 75-80% the strength of manila		
Manila good strength for natural fiber rope has good "grass" rope "feel"	subject to rotting harsh on hands likely to cause ropeburning	some use as a lariate--not suggested for tying animal limbs (legs) lead ropes, if 1/2" or larger
Polypropylene very strong, second only to nylon and dacron will not rot resistant to barn-yard acids and bases	rope burning is likely flame or heat will cause melting	good for lead ropes excellent for slinging and total restraint

Nylon
highest strength
of any rope
will not rot from
water or mildew

will stretch
very likely to
cause ropeburning
flame or heat
will cause melting

strongest lead
rope available
excellent for
slinging and
total restraint

- d. Wet rope should be dried in the shade in the open air before coiling and storing. This is especially important when handling natural fiber ropes which are susceptible to rot and mildew.
- e. Remove all kinks from the rope before storing.
 - 1) To remove kinks, lay the rope out full length and drag one end for about one-half the length of the rope.
 - 2) Prevent kinks by coiling the rope in the same direction in which the strands are laid.
- f. Remove all knots from the rope before storing.
 - 1) Knots decrease the breaking load of ropes. A single overhand knot decreases the strength of the rope by 65%.
- g. Secure the ends of ropes to prevent fraying.
 - 1) Use an end splice or whip the ends of natural fiber ropes.
 - 2) Melt the ends of synthetic fiber ropes or dip them in adhesive.
 - 3. Lubricate wire ropes with oil or grease and prevent exposure to water to avoid rust problems.

C. Working Safely with Rope

- 1. Most injuries involving the use of rope come from three factors:
 - a. Rope burns
 - b. Broken ropes
 - c. Entanglements
- 2. To avoid injuries from rope burns:
 - a. Wear leather gloves when doing work with rope.
 - b. Do not wrap the rope around hands when working with livestock.

- c. Do not attempt to grab a rope that is moving under a load, or a fast moving rope.

3. To avoid injuries due to the breaking of ropes:

- a. Never stand, crawl, lie, or walk under heavy objects supported by ropes or cables.
- b. Never tow vehicles with a rope that is not designed for towing. Special nylon ropes are manufactured for this purpose.
- c. Always use a rope with the proper working strength for the job.
- d. Remove all knots from the rope that will reduce the working strength.
- e. Check the condition of the rope frequently.
- f. Never stand near a rope or cable that is under heavy stress. A cable or a rope breaking under these conditions can cause severed limbs and other serious injuries when it whips around.

4. To avoid injuries due to entanglements:

- a. Always stay away from moving ropes.
- b. Never wrap the rope around your hand or body for support.

ACTIVITY:

1. Collect different sizes and types of rope. Have an identification quiz at the end of the period.
2. Have the students practice coiling rope. Divide the class into teams and have a relay race coiling the rope.
3. Bring samples of damaged ropes to class. Inspect the ropes for damage and identify methods of either preventing or repairing the damage.
4. Demonstrate the weakening effect of knots on rope. String can be used instead of thick ropes. Hang objects from the string that has no knots. Then tie overhand knots in the string and see if the same amount of weight will break it.

KNOTS, HITCHES, AND THEIR USES

A. Knots: Knots generally stay tight without the necessity of a steady pull or strain on the rope.

1. The Square Knot is used to tie together two ropes of the same size.
 - a. The Square Knot will not slip and is easy to untie. (Page 130J-14)
 - b. The Square Knot should be distinguished from the Granny Knot which appears similar but binds, is difficult to untie, and will slip.
2. The Sheet Bend (or Carrick Bend) is used to tie together two ropes of unequal diameter. (Page 130J-15)
3. The Manger Hitch is not a hitch, but a knot used to tie livestock to something.
4. The Cat's Paw is used to hold a line to a hook when lifting a load.
5. The Bowline forms a loop that will not slip, yet is easy to untie. (130J-15)
 - a. The Bowline is used to tie around the neck of livestock because it will not tighten and strangle the animal.
 - b. The Bowline is the most common knot used in mountain climbing and rescue work.
6. The Sheep Shank is a knot used to shorten a rope or take the slack out of a rope without cutting it. (Page 130J-16)
 - a. The Sheep Shank can also be used to bypass a damaged section of rope.
 - b. The Sheep Shank depends upon the rope being taut; therefore, slack will cause the knot to untie.
7. The Figure Eight Knot is used to prevent the end of the rope from unraveling or being pulled through a pulley. Most commonly used on tying handles on ropes; for example, starter ropes on lawnmowers. (Page 130J-16)

B. Hitches: Hitches are a temporary method of fastening that depend on the pull of the rope to keep them tight.

1. The Double Half Hitch is used to tie a rope around a post or through a ring or grommet.
2. The Taut-Line Hitch is used to keep a line taut or tight. When used on a tent or a guy line, the tension can be adjusted by pushing the hitch up or down the standing part.
3. The Clove Hitch is used to secure a rope to a post or a pole. (Page 130J-17)

130J-10

- a. The Clove Hitch is used to start and finish many lashings.
 - b. The Clove Hitch is also referred to as an "H-Knot" and is very easy to untie.
4. The Timber Hitch is used to secure logs or objects that will be towed or dragged. (Page 130J-17)
 5. The Trucker's Hitch is used to tighten a line over a load to secure the load. There are several variations to this hitch.

C. Ropework has its own specialized terminology:

1. A bight means to bend the rope back on itself to make a "U."
2. A turn or a hitch refers to the passing of a rope all the way around an object such as a post, a rail, or another rope.
3. A standing line is the main rope that leads to the object being tied.
4. The working line is the end of the rope that is passed around or through so as to actually tie the knot or hitch.
5. To "serve a line" means to wrap a line with cord to strengthen or protect the line and to add a finished look to a splice.

D. Safety considerations must be made before choosing a knot or a hitch.

1. Using a slipknot, or any binding knot, to tie around the neck of an animal or the waist of a person is dangerous. Animals can be strangled and ribs can be broken. Always use a Bowline to tie loops.
2. A Manger Hitch is used as a quick release mechanism for tying animals. If a knot is tied that binds when the animal pulls, the animal can choke if it falls or lies down. A binding knot cannot be untied while the animal is struggling. The Manger Hitch can save the animal's life in this situation.

ACTIVITY:

1. Have the students demonstrate tying the knots and hitches by timing them during a knot relay.
2. Have the students make a knotboard.
3. Have a knot tying station in the shop where students can see knots and hitches and have ropes available to practice tying knots and hitches.
4. Have students practice tying starter rope handle on a lawn mower.
5. Decide which particular knots and hitches are appropriate to use in varying situations.

SPLICING ROPE

A. Splices are used to finish the ends of a rope, join or repair two ropes, or to put an eye or a loop in a rope.

1. A crown and end splice is used to finish the end of a rope. (Page 130J- 18)
 - a. The finished diameter of the splice is larger than the diameter of the rope. This causes problems where the end of the rope must be passed through a loop or a ring.
 - b. Whipping the ends of the rope can replace a crown splice where the finished diameter is important.
2. An eye splice is often used when a permanent loop is required in the end of the rope. (Page 130J-19)
3. A short splice is used to join two ropes together.
 - a. A short splice also increases the diameter of the rope.
4. A side or loop splice is used to put an eye in the middle of a rope. (130J-20)

B. Making Splices and Halters (Page 130J-20)

1. A splice reduces the breaking strength of a rope by 20-35% as opposed to 65% for knots.
2. Splices should be attempted only on three-stranded rope for beginners.
3. A pair of side-cut pliers can be used to trim the rope in order to avoid the use of knives in the classroom.
4. A marlin spike or a 20d nail is useful in separating the strands of the rope.
5. Taping the ends of the strands on natural fiber ropes or melting the ends on synthetic ropes will prevent fraying and make it easier to pass the strands through one another.
6. Eyes or loops designed to have a rope pass through them should be no more than 1 1/2 times the diameter of the rope that is to pass through the eye.
7. Consider the size of the head of the animal (calf, cow, bull, etc.) and the length of the lead rope when determining how much rope to start with.
8. Always finish the splice by rolling it between your hands or under your foot to set the strands.

ACTIVITY:

1. Have the students practice making splices until they are proficient.
2. Have the students combine the different splices they have learned to make a halter.
3. Use a splice relay to motivate students through competition.

ROPEWORK, EXAM

Matching

- | | |
|--------------------------|--|
| 1. _____ Bowline | A. Used to shorten rope |
| 2. _____ Clove Hitch | B. Used to tie up an animal |
| 3. _____ Manger Hitch | C. Used to adjust a tent line |
| 4. _____ Sheet Bend | D. Used to join two ropes of the same size together |
| 5. _____ Sheep Shank | E. Won't slip. Used in rescue work. |
| 6. _____ Square Knot | F. Used to join two ropes of unequal diameter together |
| 7. _____ Taut Line Hitch | G. Starts and ends lashings |

8. Name the three most common causes of injuries in ropework.

9. List five materials used to make rope and the advantages and disadvantages of each.

10. Using the attached chart on rope strength, what size nylon rope would you use to lift a market steer that weighs 1,200 pounds?

11. What is the breaking strength of a 3/4" manila rope?

12. What factors affect the selection of rope for a particular job?

REFERENCES:

Birkby, Robert C. (1990). BOY SCOUT HANDBOOK (10th ed.). Boy Scouts of America, Irving, Texas (Check the telephone book under Boy Scouts of America for name of local retail store or supply house that handles scouting supplies.)

Jurgenson, E. M. (1979). HANDBOOK OF LIVESTOCK EQUIPMENT (2nd ed.). Danville, IL: Interstate Publishers.

Battaglia, R. A., & Mayrose V. B. (1981). Handbook of Livestock Management Techniques. Minneapolis, MN: Burgess Publishing.

RESOURCES:

USING ROPES IN ANIMAL AGRICULTURE (1975). (12 pages).

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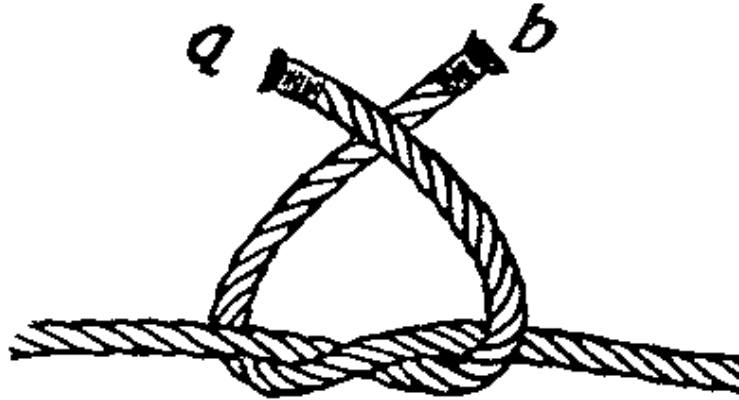
Special Materials and Equipment:

Three-foot lengths of 1/4" or 3/8" rope for each student. Examples of knots on a knot board. For the purpose of this lesson, baler twine can be substituted for rope because it is cheaper and more flexible. Four or five poles for practicing hitches. Samples of nylon, polypropylene, sisal, manila, cotton, and wire rope; also, samples of misused and defective rope. Three- or four-foot lengths of 1/4" or 3/8" three-stranded rope for each student. (To make a rope halter, a minimum of four feet of rope is required.) A knotboard showing examples of the different types of splices.

Answer Sheet, Exam

- | | |
|------|--|
| 1. E | 8. Rope burns, Broken Ropes, Entanglements |
| 2. G | 9. Check the chart on page 130J-6 |
| 3. B | 10 5/8" |
| 4. F | 11. 1,080lbs |
| 5. A | 12. Use, Size, Strength, Flexibility, Durability, Cost |
| 6. D | |
| 7. C | |

SQUARE KNOT



Square Knot – One of the most frequently used and best knots for tying ropes together.

Step 1 – Tie the ends together with a simple right-over-left overhand knot.

Step 2 – Then cross strand A in front of B, and tie a left-hand overhand knot.

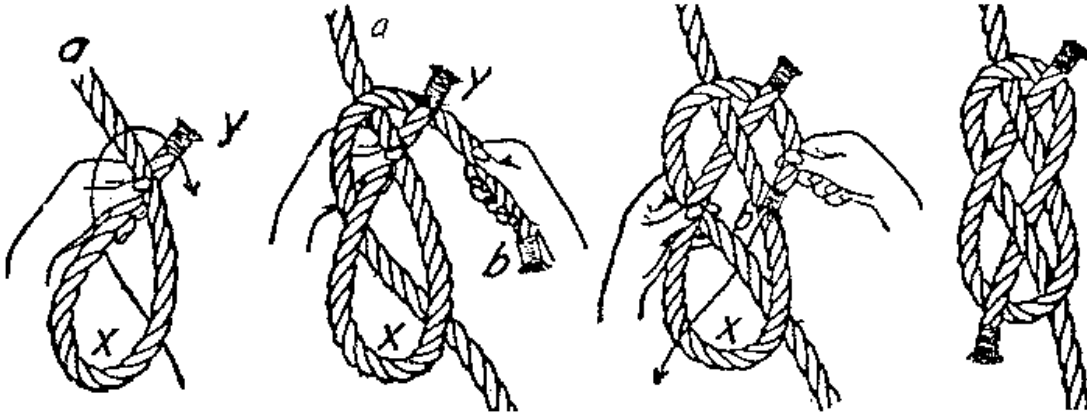
Step 3 – Draw tight.

GRANNY KNOT



Note; similar to the square knot but it will not hold under tight tension.

SHEET BEND



Sheet Bend – Used to tie together two ropes of unequal diameter.

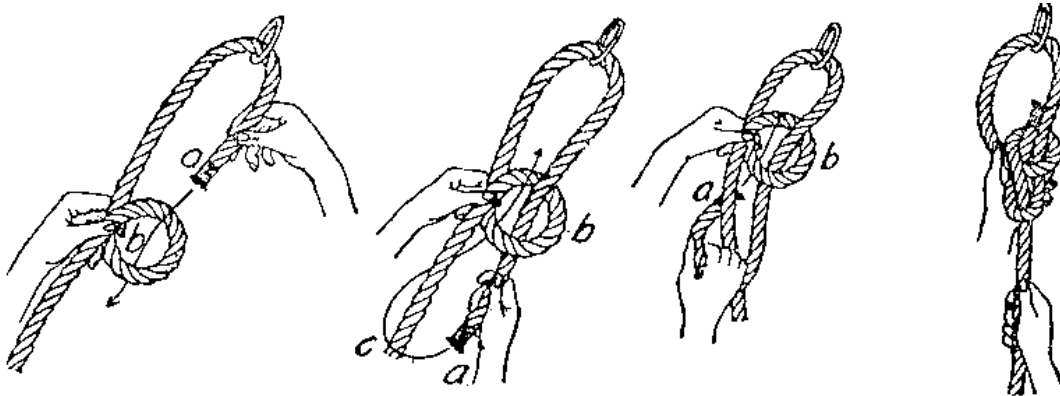
Step 1 – Make a loop in the end of a rope with the Y end under the standing part of the rope A. Hold with the left hand.

Step 2 – Pass the end of the rope B under the loop X, over the standing part at A, and under the end Y.

Step 3 – Hold the knot together with the left hand and continue with end B, passing it over the right side of the loop X, under the standing part of B, then over the left side of loop X as indicated by the arrow.

Step 4 – Hold parts in position and draw tight.

BOWLINE KNOT



Bowline Knot – Most common knot used in mountain climbing, rescue work, and Livestock.

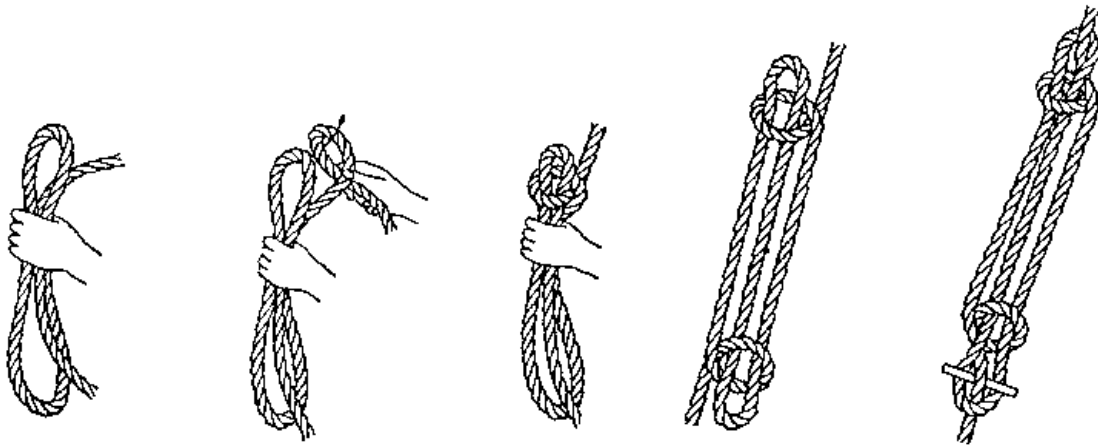
Step 1 – Place the end of the rope through a ring or around a object to which it is to be tied.

Step 2 – With the left hand, make a loop in the standing part of the rope as shown above.

Step 3 – Bring end A through loop B from the upper side, passing it around the standing part of the rope at C, and then up through loop B as shown above.

Step 4 – Draw knot tight.

SHEEP SHANK KNOT



Sheep Shank – Used to shorten a rope or take the slack out of a rope without cutting it.

Step 1 – Make two loops which are long enough to remove the slack. Hold the loops with the left hand.

Step 2 – Make a half hitch, with the right hand, in the rope near one end of the loop and slip it over the end of the loop.

Step 3 – Make another half hitch over the other end of the loop. This completes the hitch.

Step 4 – The hitch may be fastened permanently by passing the ends of the rope through the loops.

FIGURE EIGHT KNOT

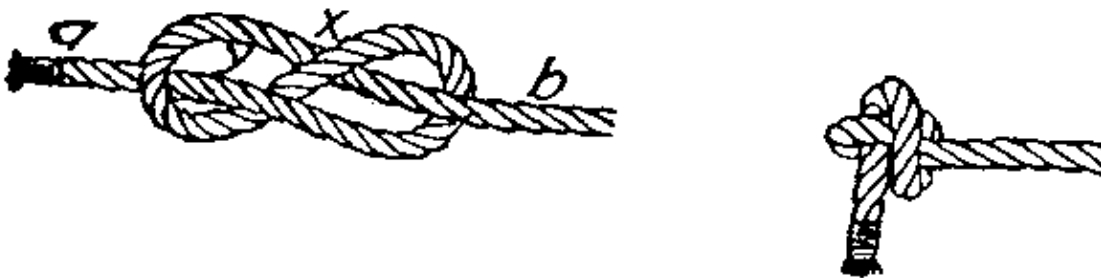


Figure Eight Knot – Most commonly used on Briggs and Stratton lawnmowers with pull starters.

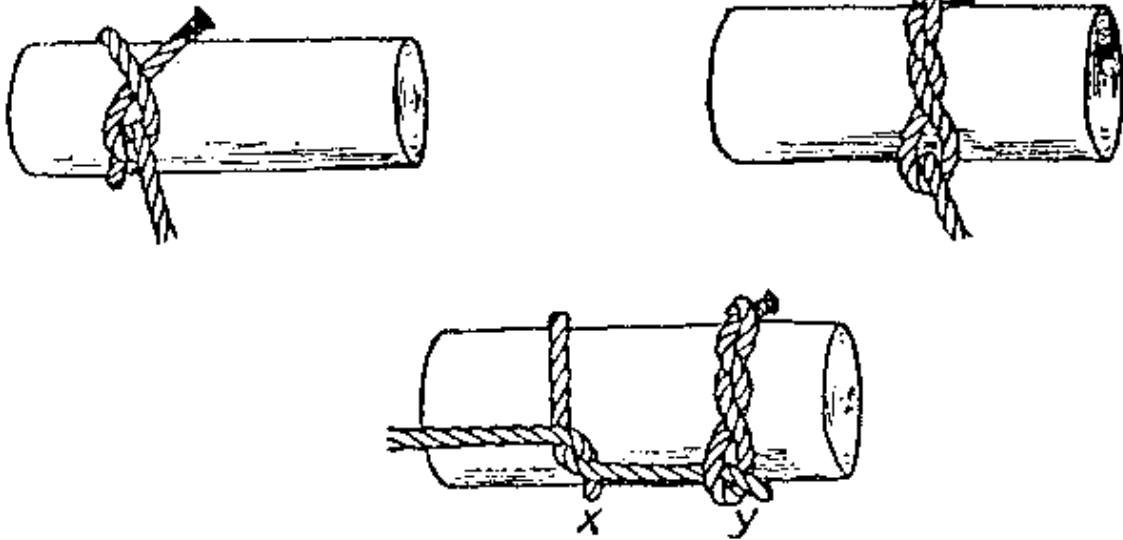
Step 1 – Make a loop near the end of the rope.

Step 2 – Give the short end A, a complete turn around the standing part of the rope B and pass it through the loop at Y

Step 3 – Pull tight.

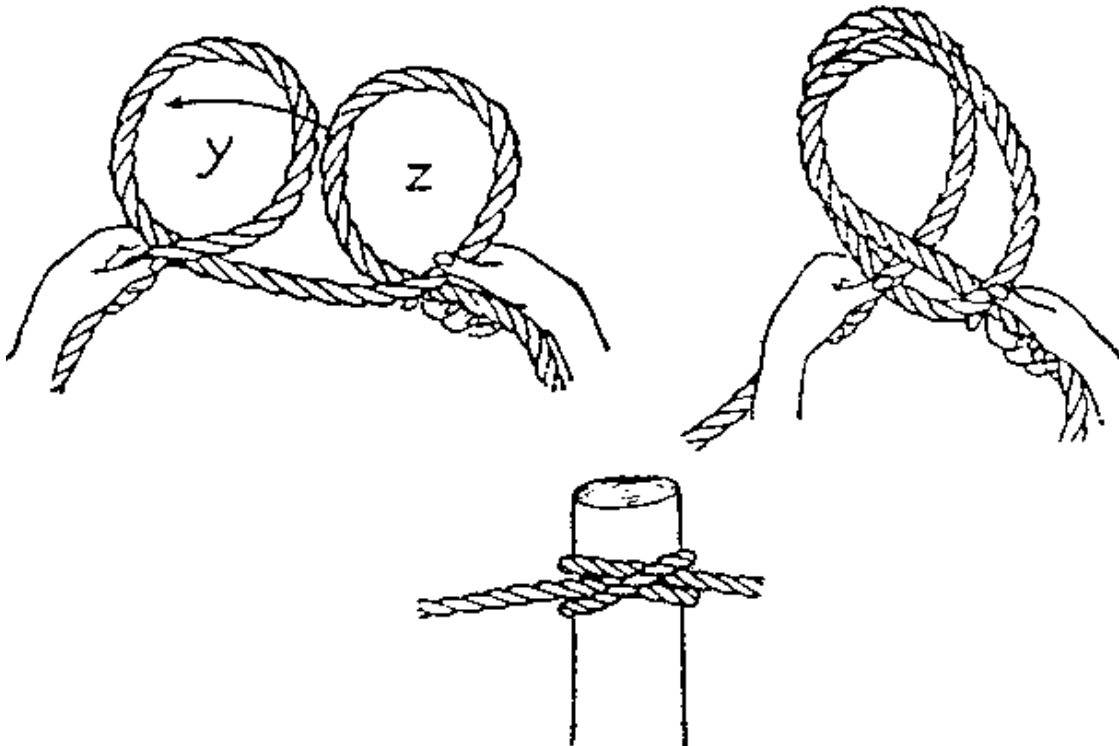
Step 4 – When using this knot for pull starters, place the pin through the loop at Y, then pull tight

TIMBER HITCH AND HALF HITCH



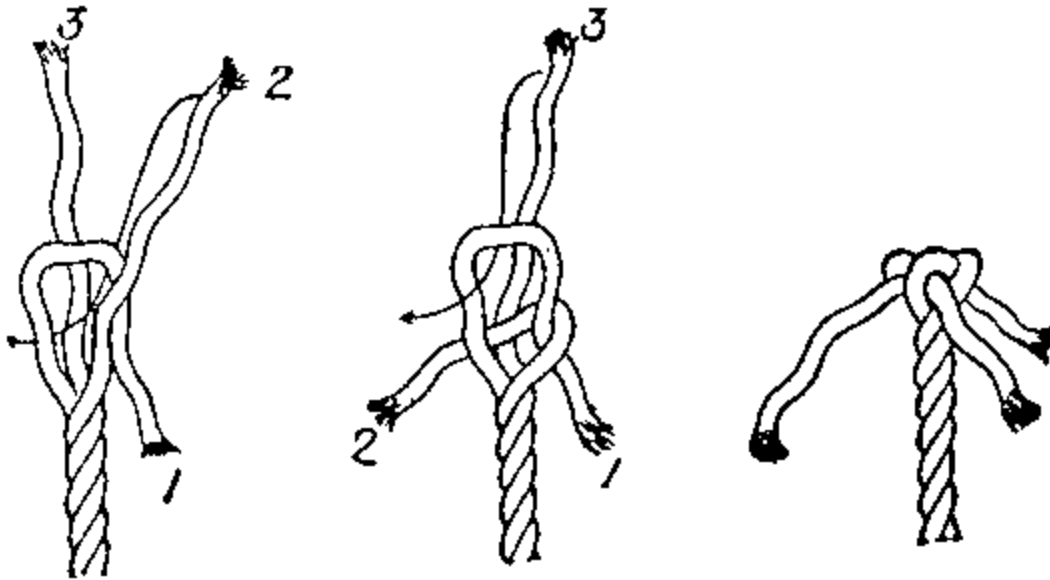
Half Hitch – x Timber Hitch – y

CLOVE HITCH



Clove Hitch – Make two loops in the rope – one to the left, other to the right. Move loop Z over loop Y. Place over the top of a post or stake and pull tight.

CROWN KNOT AND END SPLICE



Crown Knot and End Splice – Used to finish the end of the rope.

ABOVE

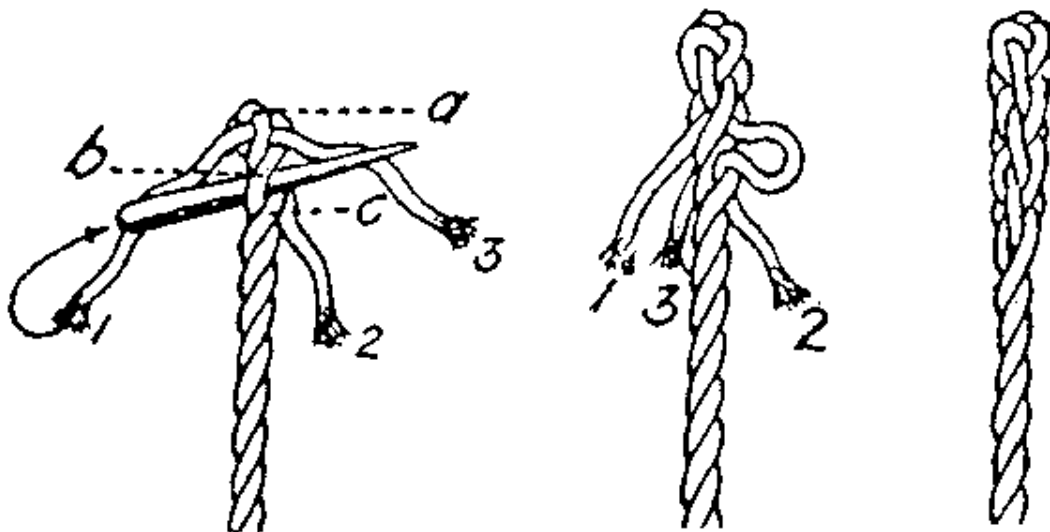
Step 1 – Pass strand 1 to the right over the strand nearest to it on the main rope and under the next strand, pulling it through tightly in a diagonal direction, almost at right angles to the twist of the strands

Step 2 – Handle strands 2 and 3 in the same manner, passing over the main strands next to them and under the following strands.

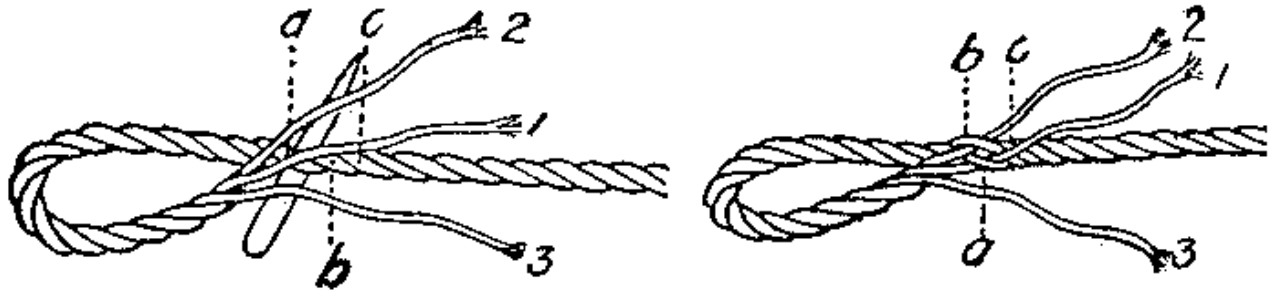
BELOW

Step 3 – Continue with each strand until they have been spliced in, over one strand and under the next for three or four times. A spike may be used to raise the strands.

Step 4 – Smooth the crown by rolling it under the foot and by removing the loose ends. The finished end should have the appearance of the splice below.



EYE SPLICE



Eye Splice – Used when a permanent loop is required in the end of the rope.

Step 1 – Unravel the end of the rope about five turns.

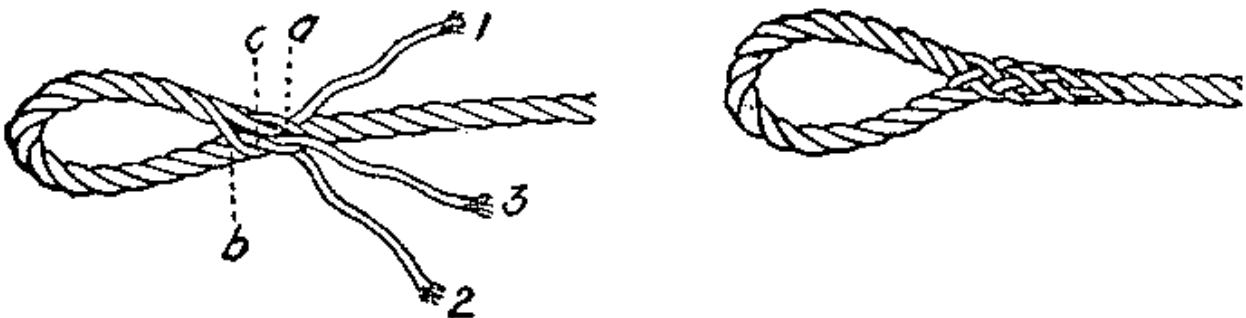
Step 2 – Bend the rope end back on the main part of the rope to form a loop of the desired size. The two outer strands should straddle the rope, the center strand lying on top of the rope.

Step 3 – Raise a strand in the main rope and pass the middle loose strand under it in a direction opposite to the twist of the main rope.

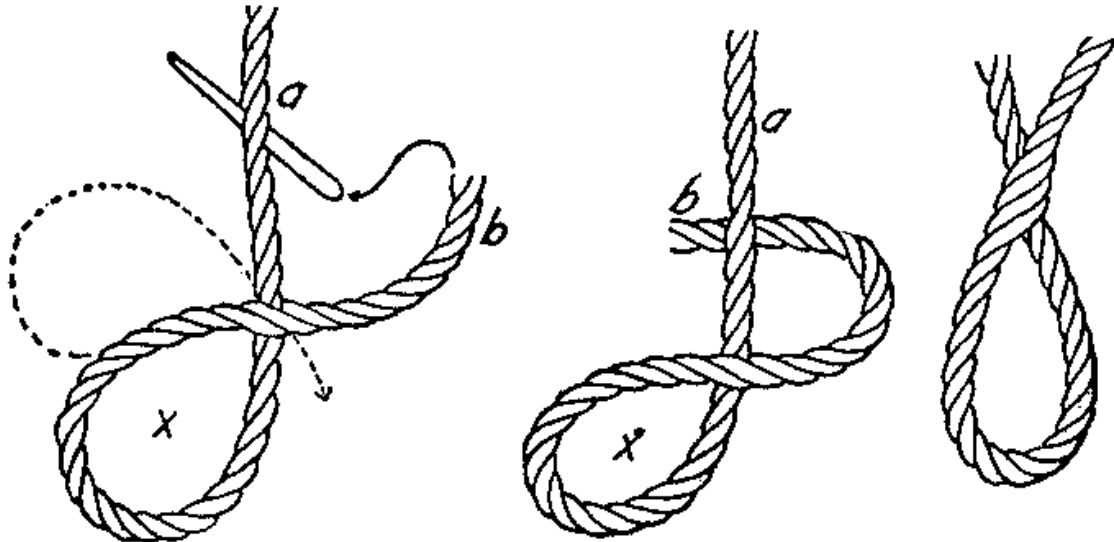
Step 4 – Weave this strand into the main rope, passing it over the strand next to it, under the second strand, and so on.

Step 5 – Tuck in the other two strands in the same manner. Make sure that each loose strand passes over and under but one strand at a time, and that each loose strand is separated by main rope strands.

Step 6 – The finished splice should look similar to the eye splice below



LOOP SPLICE



Loop Splice – Mainly used in rope halters.

Step 1 – Raise two strands in the rope where the loop is to be made.

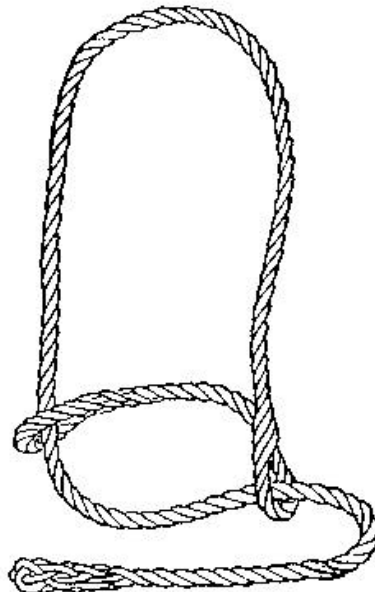
Step 2 – Pass the long end A, which will be the lead rope of the halter through the opening under the raised strands. It is important that the rope A cross under the two strands at right angles to the direction in which they are laid. (The dotted line indicates the improper direction for passing the rope under the strands.) Draw the loop to the desired size.

Step 3 – Raise two strands in the long part of the rope A as indicated.

Step 4 – Pass the short end of the rope through this opening.

Step 5 – Work the ropes closely together, completing the loop splice as shown above

ROPE HALTER



130J-21

TRUCKER'S HITCH

